element 20 may comprise a read/write micro-chip 22 including a wire antenna 24 connected thereto, any other suitable electronic element. These electronic elements 20, 22 and 24 and their insertion into plastic cards is not new, however, the present invention provides a new hot lamination process for manufacturing plastic cards 10 with these electronic elements embedded therein such that the cards 10 are of a superior quality, meet all ISO and other industry specifications and standards, and are sufficiently smooth and otherwise is capable of receiving dye sublimation printing. Electronic elements such as these described are available from manufacturers such as Motorola and Philips Electronics.

Upper surface 12 contains a window or cavity 16 formed therein and intended to expose one or more contact pads 26 operatively connected to antenna 24. Upon formation of card 10 in accordance with the preferred embodiment, a microprocessor chip 22 is inserted into window 16 and in electrical connection with contact pads 26. This microprocessor chip may function as a "proximity" or radio frequency identification (RFID) card in conjunction with antenna 24 when electromagnetically used with a compatible terminal reader. Microprocessor chip 22 is also capable of function as a contact card, requiring physical contact between a compatible terminal reader and the surface of chip 22. It should be appreciated that the contact function of the card may be accomplished by any contact sensor whether integral to or physically separate from chip 22 and that window 16 may be formed anywhere on surfaces 12 and/or 14 as will accomplish the purposes of the invention.

Specifically, a card in accordance with the present invention has a thickness of approximately in the range of 0.028 inches to 0.032 inches with a surface smoothness of 0.0005 inches. In order to meet the ISO standards for such cards, these tolerances apply to the surface of

the microprocessor chip 22 surface as well as to the surface of plastic portion of card 10. It is to be appreciated that cards having a thickness greater than .032 inches can easily be manufactured in accordance with the teachings herein while meeting all of the other criteria of the present invention. However, the foreseen product demand is for cards meeting the aforementioned standards.

As shown in Fig. 4, one or more cards 10 in accordance with the present invention may be manufactured by positioning an electronic element 20, including contact points 26, between first and second sheets of card stock 30, 32 to form a core 33. Preferably as shown, a plurality of cards are manufactured simultaneously, and accordingly a plurality of electronic elements 20 are positioned between the first and second sheets of plastic core stock 30, 32. When a plurality of electronic elements 20 are positioned between first and second sheets plastic core stock 30, 32, electronic elements 20 are properly positioned relative to one another such that a plurality cards may be cut from the resulting card stock.

Plastic core sheets 30, 32 may be provided by a wide variety of plastics, the preferred being polyvinyl chloride (PVC) having a thickness in the range of 0.007 inches to 0.024 inches and preferably having a thickness of approximately 0.0125 inches each. Those skilled in the art will recognize that the thickness of the plastic core sheets will depend somewhat upon the thickness of the one or more electronic elements that are to be embedded therebetween if ISO standards are intended to be met. Other suitable plastics that may be utilized include polyester, acrylonitrile-butadiene-styrene (ABS), and any other suitable plastic.

Subsequent to placing one or more electronic elements 20 between the first and second sheets 30, 32 of plastic core stock to form a core 33, this core 33 is placed in a laminator

apparatus 40 of the type well known in the art of plastic card manufacturing. As is shown in Fig. 5, laminator 40 includes upper and lower platens 42,44 for applying ram pressure to an article positioned therebetween. In addition to the ability to apply ram pressure, laminator 40 is preferably of the type having controlled platens 42,44 that may provide both heat and chill cycles and preferably includes cycle timer to regulate cycle time. Core 33 is positioned between first and second laminating plates 50, 52, one of which is preferably matte finished to provide laminated core 33 with at least one textured outer surface. First and second laminating pads 60, 62 are positioned outside of the laminating plates 50, 52, and first and second steel plates 70, 72 are likewise positioned outside of pads of 60, 62 and the entire assembly forms a book 35 for being positioned in laminator 40 between platens 42, 44.

Once book 35 is positioned in laminator 40 as shown in Fig. 5, the first lamination cycle is initiated by closing laminator platens 42, 44, preferably applying little or no ram pressure to book 35. This is preferably done using hydraulic pressure, and a pressure not to exceed about 10 pounds per square inch is believed sufficient for most applications.

A laminator heat cycle is initiated, bringing the temperature of platens 42,44 up to a range of 275°F to 400°F, and most preferably up to a range of 300°F to 370°F for a period of ranging between 1 to 20 minutes, but preferably greater than 5 minutes, and most preferably in the range of 7 to 10 minutes for PVC material. It must be understood that the temperatures recited herein are by means of example. The use of thermoplastic material other than PVC or the presence of pigments in the core material may require modification of the heat cycle temperature.

Once the heat cycle has been applied to book 35 as is set forth above, the ram pressure of laminator 40 is increased to facilitate the flow of the plastic core sheets 30, 32 so that the one or more electronic elements 20 become encapsulated thereby, and so that sheets 30, 32 form a uniform core 33 with upper and lower surfaces 34,35. The ram pressure translates into an effective pressure on core 33 in the range of 200 to 450 psi and preferably in the range of 250 to 350 psi. As can be expected temperature and pressure are inversely related to one another. In other words a lamination cycle at a higher temperature will require less pressure to be applied to core 33, and conversely a lower temperature heat cycle will require increased ram pressure. Damage to the electronic components can result from excessive ram pressure on the core while insufficient ram pressure will likely cause an inadequate flow of the plastic resulting in air pockets or an irregular card surface.

As mentioned, the use of matte finished laminator plates 50,52 provides surfaces 34,35 with a slightly roughened or textured quality which will facilitate the application of a coating thereto as is discussed below. The ram pressure applied during the heat cycle and the length of the heat cycle may vary, depending especially upon the size of sheets 30, 32. For example, the cycle time may be in the range of 10-15 minutes. In one example, at a temperature of approximately 320 degrees Fahrenheit, a ram pressure of 940.135 pounds per square inch (p.s.i.), producing a pressure of about 275 psi at the core 33 surface, was applied for 10-15 minutes to form a uniform core 33, using sheets 30,32 of a size in the range of 12 inches by 24 inches to 24 inches by 36 inches.

Subsequent to the above heat cycle, laminator 40 applies a chill cycle to book 35 during which time the ram pressure of the laminator 40 is increased, preferably by approximately 10-40%

and most preferably about 25% until the platens 42,44 have cooled so as to return the core material to a solid state. In the preferred method the platens 42, 44 are cooled to approximately 40°F to 65°F for approximately 10-15 minutes. Core 33 may then be removed from laminator 40 for additional processing.

Subsequent to the removal of core 33 from laminator 40, and as illustrated in Fig.6, core 33 is coated on at least one of its upper and lower surfaces 34, 35 with a layer of printing ink 36. This may be accomplished using a wide variety of printing techniques such as offset printing, letterpress printing, screen printing, roller coating, spray printing, litho-printing, and other suitable printing techniques. As shown in Fig. 6, core 33 is fed in the direction indicated with arrow A through a printing press, a lithographic printer, or a similar apparatus 80. This printing step is performed to coat at least one surface 34, 35 of core 33 with a layer of aesthetically pleasing ink 36. This layer of ink 36 can also serve to cosmetically hide the one or more electronic elements 20 that are embedded within core 33, and prevent these one or more electronic elements 20 from showing through the relatively thin core 33. In this manner, the one or more electronic elements 20 encapsulated in core 33 are completely hidden from view without requiring the plastic used in the manufacture core 33 to be excessively thick (exceeding ISO standards for cards of this type).

Referring now to Fig.7, the final preferred, but optional processing of core 33, which now comprises a layer of ink 36 or the like on at least one surface 34,35 thereof, is schematically illustrated. An overlaminate layer such as clear overlaminate film 38 is positioned on at least one ink coated surface 34,35 of core 33, and preferably core 33 is positioned between two similar sheets of overlaminate film 38,39 as shown. Overlaminate film is very thin, for example in the range of 0.0015" thick. A book 135 is then constructed for insertion into laminator 40 as is

schematically illustrated in Fig. 7. Book 135 comprising core 33, including at least one layer of ink 36 and at least one layer of overlaminate film 38, 39 is positioned between laminating plates which are preferably highly polished plates such as mirror finished stainless steel plates 90, 92. Book 135 also comprises first and second laminating pads 60, 62 and first and second steel plates 70, 72 as is discussed above in relation to Fig. 7.

When book 135 is positioned between upper and lower platens 42,44 of laminator 40 as shown in Fig. 10, the laminator is closed and a heat cycle in the range of 175° F to 300° F, and most preferably in the range of 180°F to 275°F, is applied to book 135 for a period of 10 to 25 minutes to produce a pressure on book 135 of between 200 to 450 psi, preferably 250-350 psi, with a ram pressure that varies depending upon sheet size or the ram size of the laminator 40, but which is typically approximately 1000 p.s.i. with an 18 inch diameter ram. This step causes the overlaminate layer 38 to flow in order to produce a uniform protective layer over the printing.

The laminator 40 is then caused to execute a chill cycle, preferably with a corresponding increase in ram pressure. For example, the chill temperature may be in the range of 40° F to 65° F and last for a period of 10 to 25 minutes. However, any combination of temperature and time which permits the re-solidification of the overlaminate layer 38 may be used. A ram pressure increase of approximately 10 to 40% over the pressure used for the heat cycle has been found to be preferable, with a pressure increase of approximately 25% being most desirable.

It is important to note that the use of pressure, or more significantly temperature, in the second lamination cycle should only affect the overlaminate layer 38 and should not cause softening or re-flow of plastic core 33. In lieu, of this preferred overlamination process, it is to be

understood that colorfast inks may not require an overlaminate layer or that alternative overlaminates such as those applied by spray, silk screening or roll on may be used.

Subsequent to the above described second lamination cycle, a sheet of plastic card stock is provided which comprises at least core 33 with at least one surface 34,35 thereof covered by a layer of ink 36, and with at least one surface 34,35 thereof covered by a layer of overlaminate film 38, 39.

Preferably plastic card stock manufactured in accordance with the present invention comprises core 33 covered on both surfaces 34,35 with a layer of ink 36 which is positioned between layers of overlaminate film 38,39, all of which has been laminated together as described and as shown in Fig.8. One or more cards 10 then may be cut from the resulting plastic card stock and card 10 will have a thickness in the range of 0.028 inches to 0.032 inches with variation in overall thickness across the surfaces 12, 14 thereof being no greater than approximately 0.0005 inches. The one or more cards 10 can thus be said to have a glossy surface smoothness of approximately 0.0005 inches or better. Thus, a card 10 manufactured in accordance with the present invention includes at least one surface 12,14 at preferably both surfaces 12,14 that are sufficiently smooth, glossy and regular to receive dye sublimation printing.

In the preferred embodiment, each card 10 undergoes a controlled-depth milling operation to form a window or cavity 16 and to expose one or more of the contact pads 26 connected to the antenna 24. Thereafter, a microprocessor chip 22 having a contact surface is inserted into the cavity and in electronic contact with contact pads 26. Chip 22 may be attached to contact pads 26 by known means such as conductive adhesives (including those cured by UV or sonic energy)

or low temperature solder. The overall thickness of the card including the area occupied by chip 22 meets ISO standards and is capable of operation in compatible physical readers.

In an alternative embodiment, a cavity or window 16 is formed in the first or second sheet of plastic core stock, prior to the first lamination step. The core stock is positioned over the electronic element, generally 20, to expose one or more contact pads 26. This may also be done using electronic elements wherein microprocessor chip 22 is already attached to contact pads 26 and/or antenna 24 in which case the cavity is positioned over and around chip 22. As shown in Fig. 5a, a spacer 90 is inserted into cavity 16 and over contact pads 26 or chip 22. The spacer 90 may be integral to one of the matte laminating plates 50, 52 or separate therefrom and made of any suitable non-stick material such as Teflon™. Spacer 90 is utilized to prevent or limit the flow of plastic into cavity 16 during the lamination process so as not to cover contact pads 26 or chip 22 with plastic. When spacer 90 is non-integral with matte laminating plate 50 or 52 it may be removed or cut-away after either the lamination or overlamination process to expose cavity 16 and allow microchip 22 to be inserted therein and retained by such means as are known in the art, including solder or adhesives. In this embodiment where the chip is installed prior to lamination, when viewed in cross-section the outer surface of chip 22 is below the upper surface 34 or core sheet 35 prior to lamination, thus core sheets will accept the majority of applied pressure from the laminator. Spacer 90 provides further protection. As the core material softens, the plastic will flow around spacer 90 and chip 22 and the distance between the outer surface of chip 22 and the upper surface of core sheet 35 will decrease.

Those skilled in the art will recognize that the foregoing description has set forth the preferred embodiment of the invention in particular detail and it must be understood that

numerous modifications, substitutions, and changes may be undertaken without departing from the true spirit and scope of the present invention as defined by the ensuing claims.

What is claimed is:

1. A hot lamination process for the manufacture of a plastic card, said process comprising the steps of:

(a) providing first and second plastic core sheets;

(b) positioning at least one electronic element between said first and second plastic core sheets to form a layered core;

(c) positioning said core in a laminator apparatus, heating said core in said laminator, thereafter applying pressure to said core such that said at one electronic element is encapsulated in said core, and thereafter cooling said core in conjunction with laminator pressure being applied to said core, said core including an upper and lower surfaces;

(d) printing on at least one of said upper and lower surfaces of said core such that a layer of ink is applied to said at least one upper and lower surface of said core;

(e) cutting at least one card from said sheet of plastic card stock.

2. A hot lamination process as recited in claim 1 and having a further step, anywhere following step c), said step comprising: milling a region of said core to a controlled depth so as to form a cavity which exposes at least one contact pad of said electronic element.

3. A hot lamination process as recited in claim 1, wherein said step (c) of positioning said core in a laminator apparatus is carried out by positioning said core between first and second laminating plates, at least one of said first and second laminating plates having a matte finish to

provide at least one of said upper and lower core surfaces with a correspondingly textured surface.

4. A hot lamination process as recited in claim 3, wherein at least one of said first and second laminating plates includes matte finish to provide both at least one outer surface of said core with a correspondingly textured surface.

5. A hot lamination process as recited in claim 1, wherein said first and second plastic core sheets are made from a material selected from the group consisting of polyvinyl chloride, polyester, and acrylonitrile-butadiene-styrene, wherein each of said sheets has a thickness in the range of 0.007 inches to 0.024 inches.

6. A hot lamination process as recited in claim 5, wherein said first and second plastic core sheets have a thickness of approximately 0.0125 inches.

7. A hot lamination process as recited in claim 1, wherein said step (c) is carried out by:

(c1) constructing a first book including said core and at least first and second laminating plates respectively adjacent to said upper and lower surfaces of said core ;

(c2) positioning said book in said laminator apparatus;

(c3) closing said laminator apparatus and heating said core for a first predetermined amount of time without applying essentially any laminator ram pressure to said core;

(c4) increasing said laminator ram pressure following the passage of said first predetermined amount of time to apply pressure to said core in conjunction with said heating of said core; and,

(c5) cooling said core in said laminator in conjunction with laminator ram pressure being applied to said core.

8. A hot lamination process as recited in claim 7, wherein said step (c5) is carried out with a ram pressure that is greater than the ram pressure utilized in step (c4).

9. A hot lamination process as recited in claim 8, wherein the laminator pressure utilized in step (c5) ranges from about 10 to about 40% greater than the ram pressure utilized in step (c4).

10. A hot lamination process as recited in claim 7, wherein at least one of said first and second laminating plates is a matte finished laminating plate to provide at least one of said upper and lower surfaces of said core with a corresponding matte finish.

A hot lamination process as recited in claim 1 having a further step following step (d), said step comprising: positioning said core in a laminator apparatus with a layer of overlaminate film on at least one of said upper and lower surfaces of said core and laminating said layer of overlaminate film to said core in said laminator to thereby form a sheet of plastic card stock.

12. A hot lamination process as recited in claim 7, wherein said step (c3) is carried out by heating said core to a temperature in the range of 300°F to 370°F for at least 5 to 10 minutes.

13. A hot lamination process as recited in claim 12, wherein said step (c4) is carried out by increasing said laminator pressure to a pressure approximately in the range of 200 p.s.i. to 450 p.s.i. on said core for at least 10 minutes.

14. A hot lamination process as recited in claim 1, wherein said step (d) is carried out utilizing a printing press.

15. A hot lamination process as recited in claim 1, wherein said step (d) is carried out utilizing a coating techniques selected from the group consisting of silk screen printing, offset printing, letterpress printing, screen printing, roller coating, spray printing, and litho-printing.

16. A hot lamination process as recited in claim 1, wherein said step (e) is carried out by positioning said core between first and second sheets of overlaminate film such that a layer of overlaminate film is laminated to both said upper and lower surfaces of said core.

17. A hot lamination process as recited in claim 1 comprising the further step of inserting an electronic contact element into said cavity.

18. A hot lamination process as recited in claim 1, wherein said at least one electronic element is a micro-chip and an associated circuit board or wire antenna.

19. A hot lamination process as recited in claim 1, wherein said at least one electronic element is a read/write integrated chip and an associated antenna.

20. A hot lamination process as recited in claim 1, wherein said step (e) is carried out by positioning said core with said layer of overlaminate film in said laminator apparatus between first and second laminating plates, wherein at least one of said first and second laminating plates includes a highly polished surface in contact with said layer of overlaminate film.

21. A hot lamination process for the manufacture of a plastic card, said process comprising the steps of:

(a) providing first and second plastic core sheets, at least one core sheet having a cavity formed therein;

(b) positioning at least one electronic element having at least one electronic sub-component between said first and second plastic core sheets to form a layered core, said cavity positioned so as to expose said at least one contact pad therein;

(c) inserting a spacer into said cavity, said spacer substantially filling said cavity and covering said at least one electronic sub-component;

(d) positioning said core in a laminator apparatus, heating said core in said laminator, thereafter applying ram pressure to said core such that said at least one electronic element is

encapsulated in said core, and thereafter cooling said core in conjunction with laminator ram pressure being applied to said core, said core including an upper and lower surfaces;

(e) printing on at least one of said upper and lower surfaces of said core such that a layer of ink is applied to said at least one upper and lower surface of said core;

(f) removing said spacer from the cavity of said core;

(g) cutting at least one card from said sheet of plastic card stock.

22. A hot lamination process as recited in claim 21, wherein said electronic sub-component comprises one or more elements from the group consisting of a micropressor chip, a contact pad, a transponder and a contact sensor.

23. A plastic card comprising:

a plastic core including at least one electronic element embedded therein, said core having an upper surface and a lower surface;

a coating on at least one of said upper and lower surfaces; and,

a layer of overlaminate film positioned on said at least one coated surface, wherein said card has an overall thickness in the range of approximately 0.028 inches to 0.032 inches with a variation in overall thickness across the upper and lower surfaces being no greater than approximately 0.0005 inches.

24. A plastic card as recited in claim 23, wherein said core is made from a plastic selected from the group consisting of polyvinyl chloride, polyester, and acrylonitrile-butadiene-styrene.

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) AND 1.27 (b)) - INDEPENDENT INVENTOR	Docket No. 6014-2

Serial No.	Filing Date	Patent No.	Issue Date

Applicant/ Patentee: **Keith R.Leighton**

Invention: **HOT LAMINATION PROCESS FOR THE MANUFACTURE COMBINATION CONTACT/CONTACTLESS SMART CARD AND PRODUCT RESULTING THEREFROM**

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, to the Patent and Trademark Office with regard to the invention entitled above and described in:

- ☒ the specification to be filed herewith.
- ☐ the application identified above.
- ☐ the patent identified above.

I have not assigned, granted, conveyed or licensed and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who could not be classified as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

- ☒ No such person, concern or organization exists.
- ☐ Each such person, concern or organization is listed below.

*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities (37 CFR 1.27)

FULL NAME ______
ADDRESS ______
☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

FULL NAME ______
ADDRESS ______
☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

FULL NAME ______
ADDRESS ______
☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

FULL NAME ______
ADDRESS ______
☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

 P03/REV01 Patent and Trademark Office-U.S. DEPARTMENT OF COMMERCE

08918582.080997

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF INVENTOR Keith Leighton
SIGNATURE OF INVENTOR Keith R. Leighton DATE: 8-19-97

NAME OF INVENTOR ______
SIGNATURE OF INVENTOR ______ DATE: ______

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NAME OF INVENTOR ______
SIGNATURE OF INVENTOR ______ DATE: ______

08918582 · 081997

Express Mail Label No.

In application of: Keith A. Leighton

Docket No.
6014-2

Declaration and Power of Attorney For Patent Application

English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

HOT LAMINATION PROCESS FOR THE MANUFACTURE COMBINATION CONTACT/CONTACTLESS SMART CARD AND PRODUCT RESULTING THEREFROM

the specification of which

(check one)

☒ is attached hereto.

☐ was filed on _____ as United States Application No. or PCT International Application Number _____ and was amended on _____ (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)			Priority Not Claimed
(Number)	(Country)	(Day/Month/Year Filed)	☐
(Number)	(Country)	(Day/Month/Year Filed)	☐
(Number)	(Country)	(Day/Month/Year Filed)	☐

I hereby claim the benefit under 35 U.S.C. Section 119(e) of any United States provisional application(s) listed below:

(Application Serial No.)	(Filing Date)

I hereby claim the benefit under 35 U. S. C. Section 120 of any United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. Section 112. I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, C. F. R., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
08/727,789	10/07/96	Pending
60/024,255	08/21/96	Pending

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

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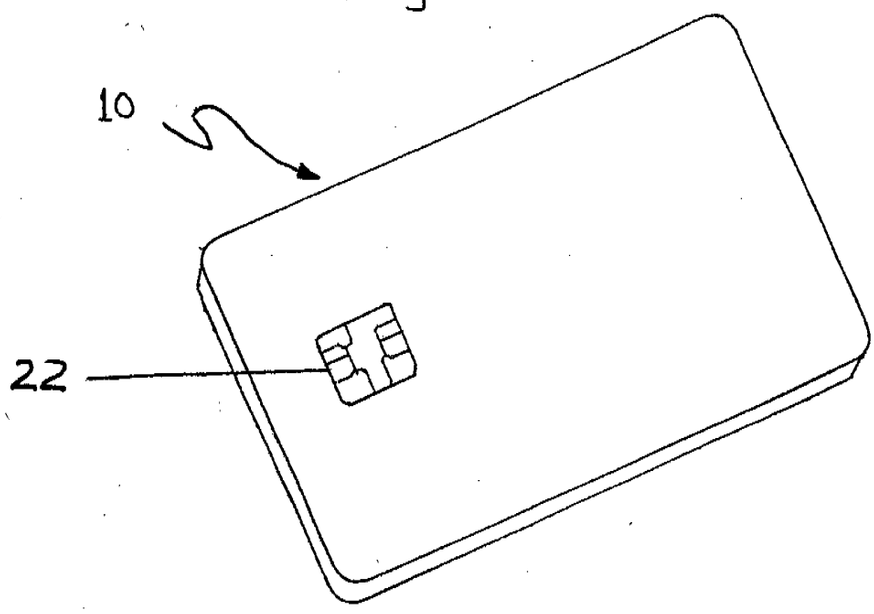
Lorain, Ohio 44053	

Full name of second inventor, if any	
Second inventor's signature	Date
Residence	
Citizenship	
Post Office Address	

Fig. 1



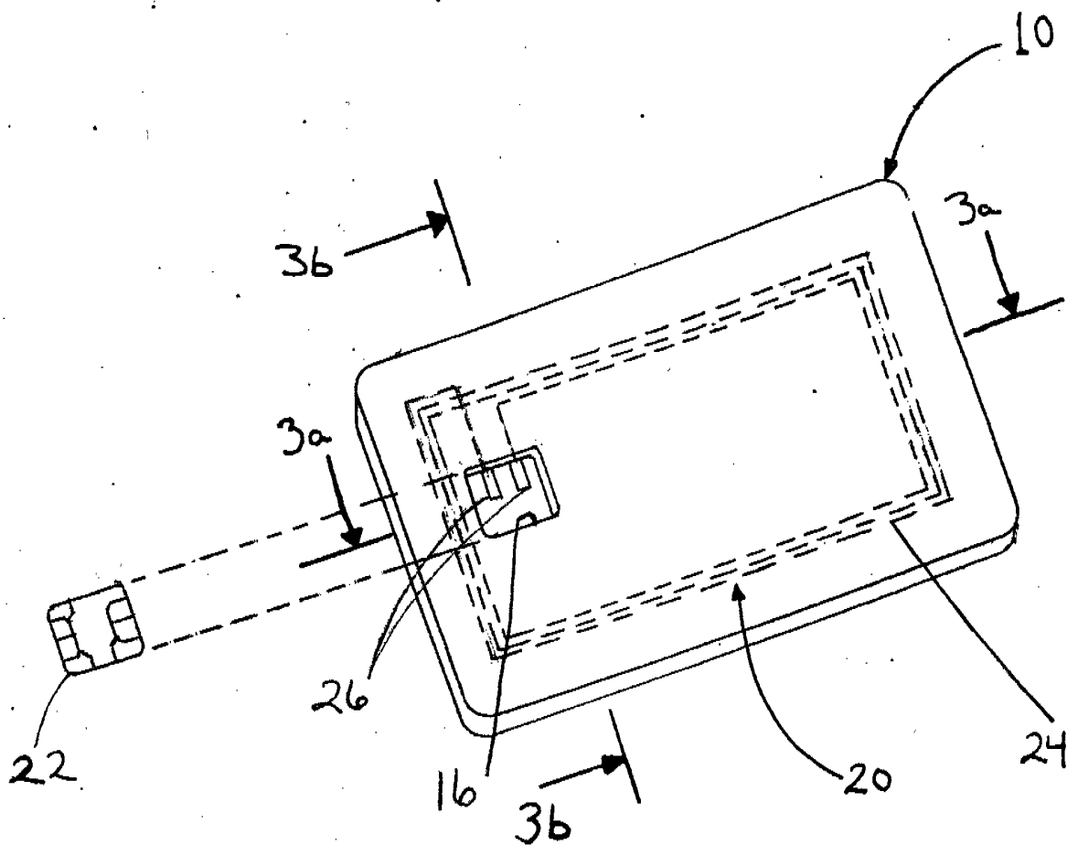


Fig 2

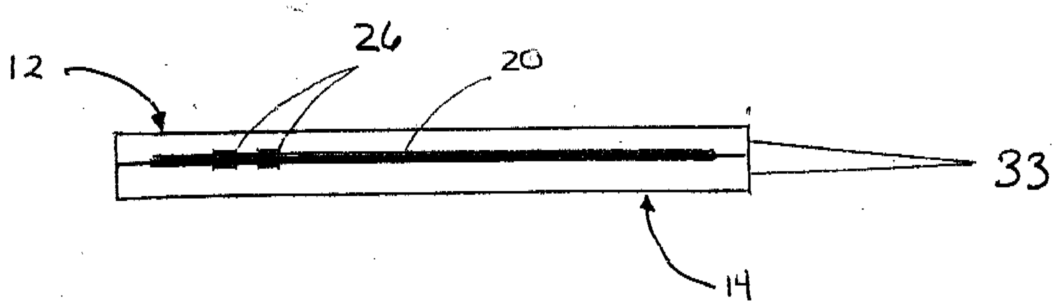


Fig 2a

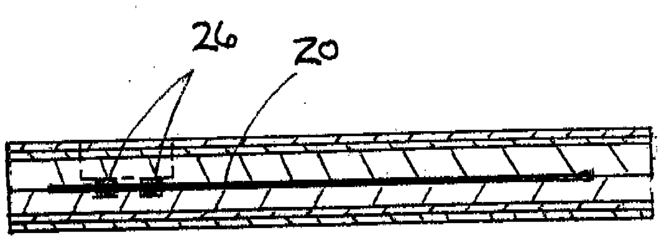


Fig 3

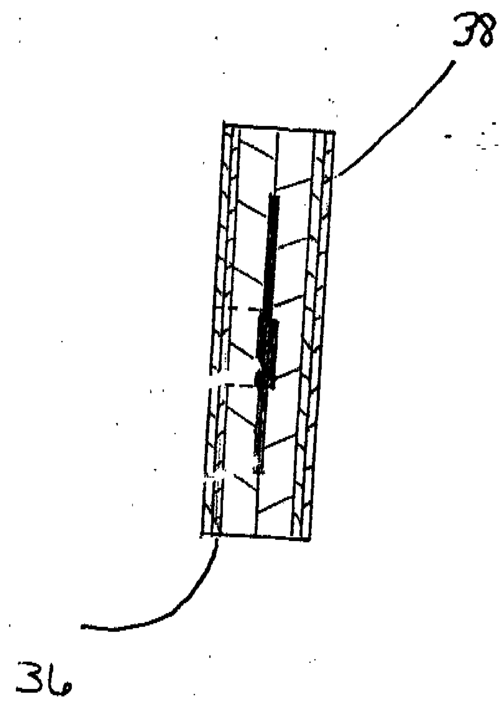


Fig. 3a

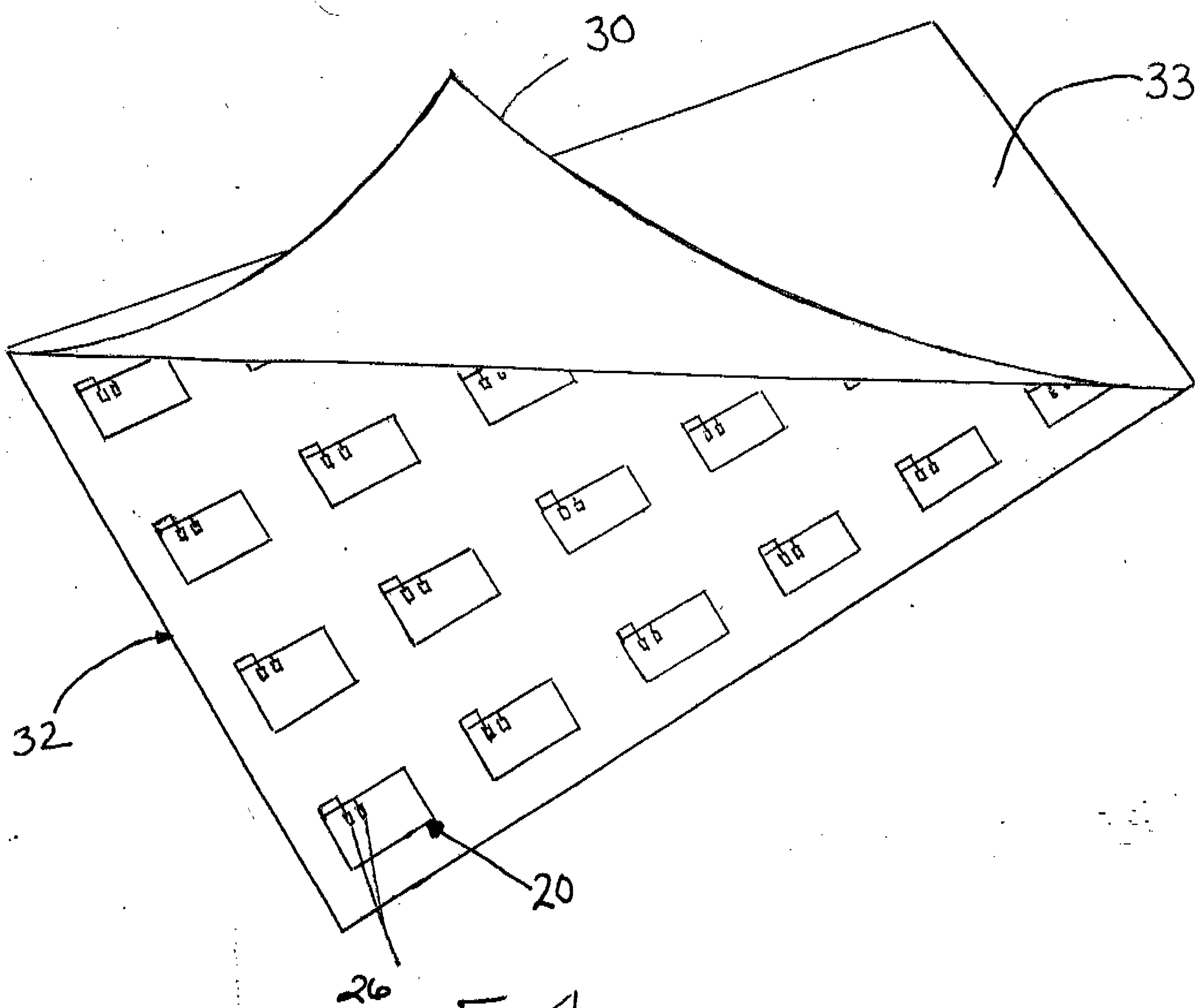
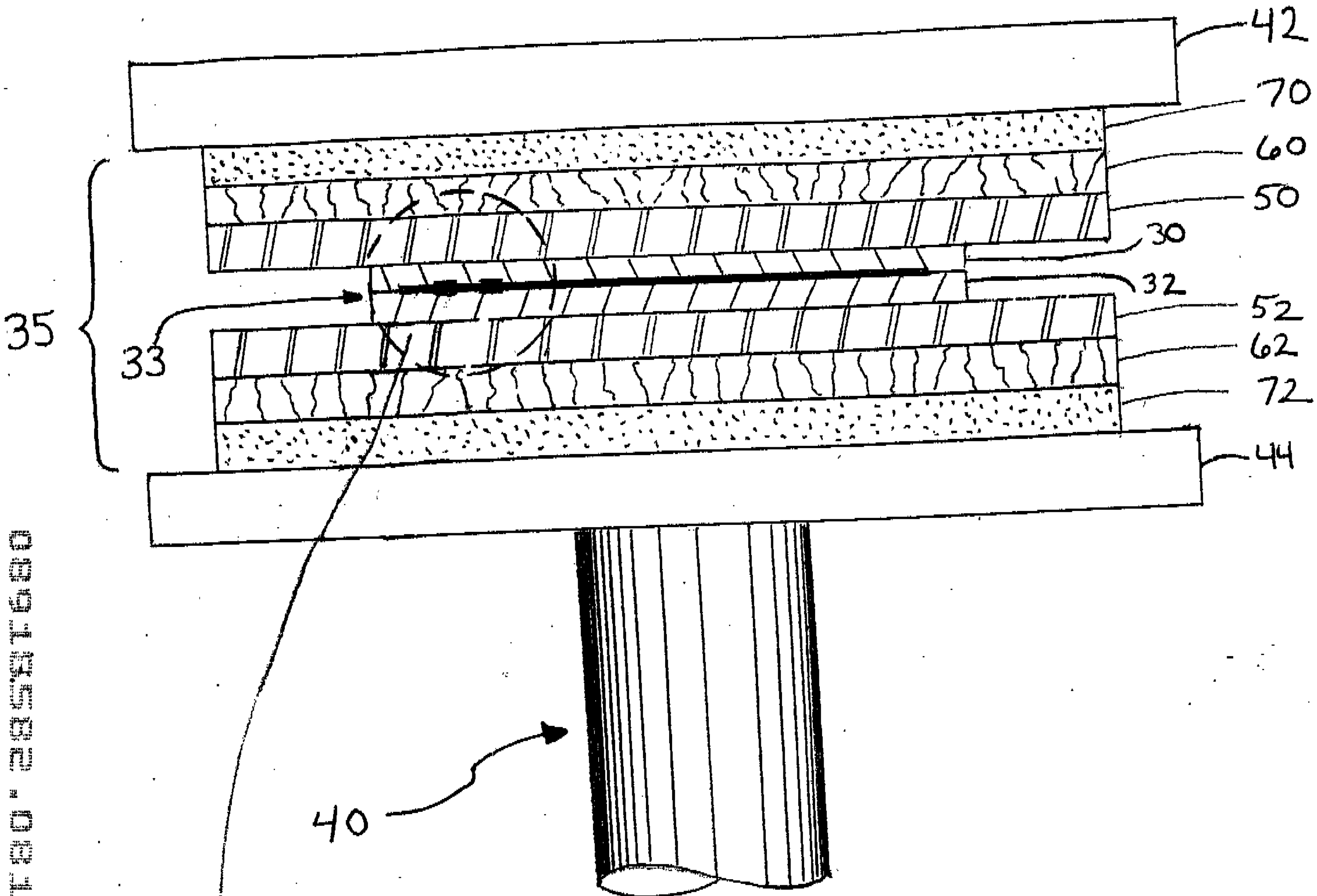


Fig. 4

Fig. 5



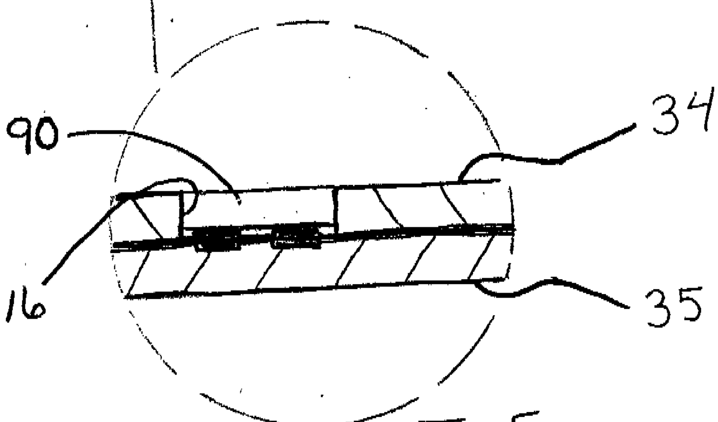
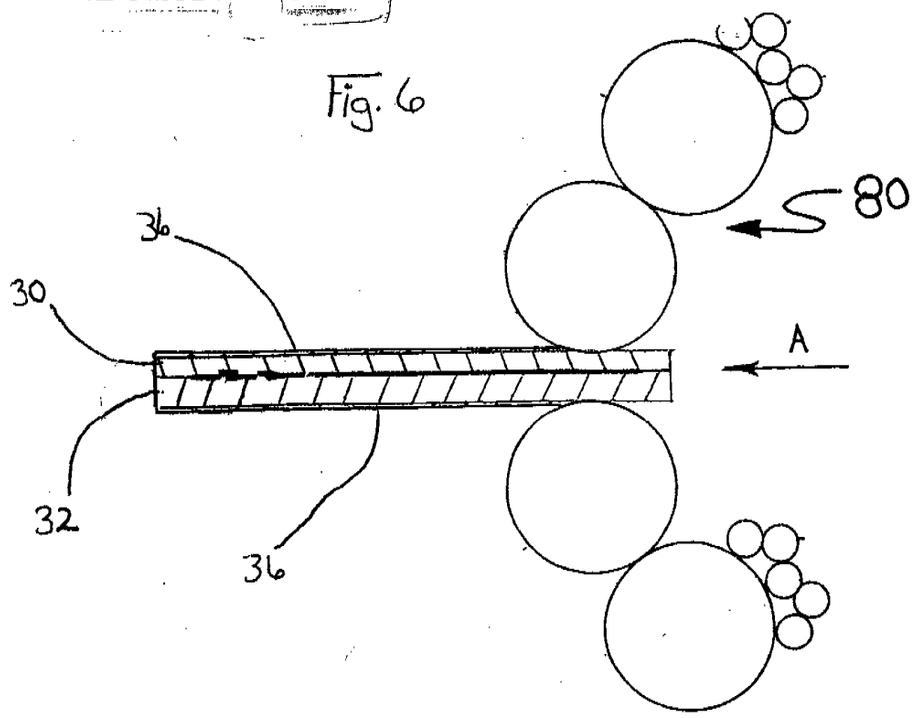


Fig. 5a

Fig. 6



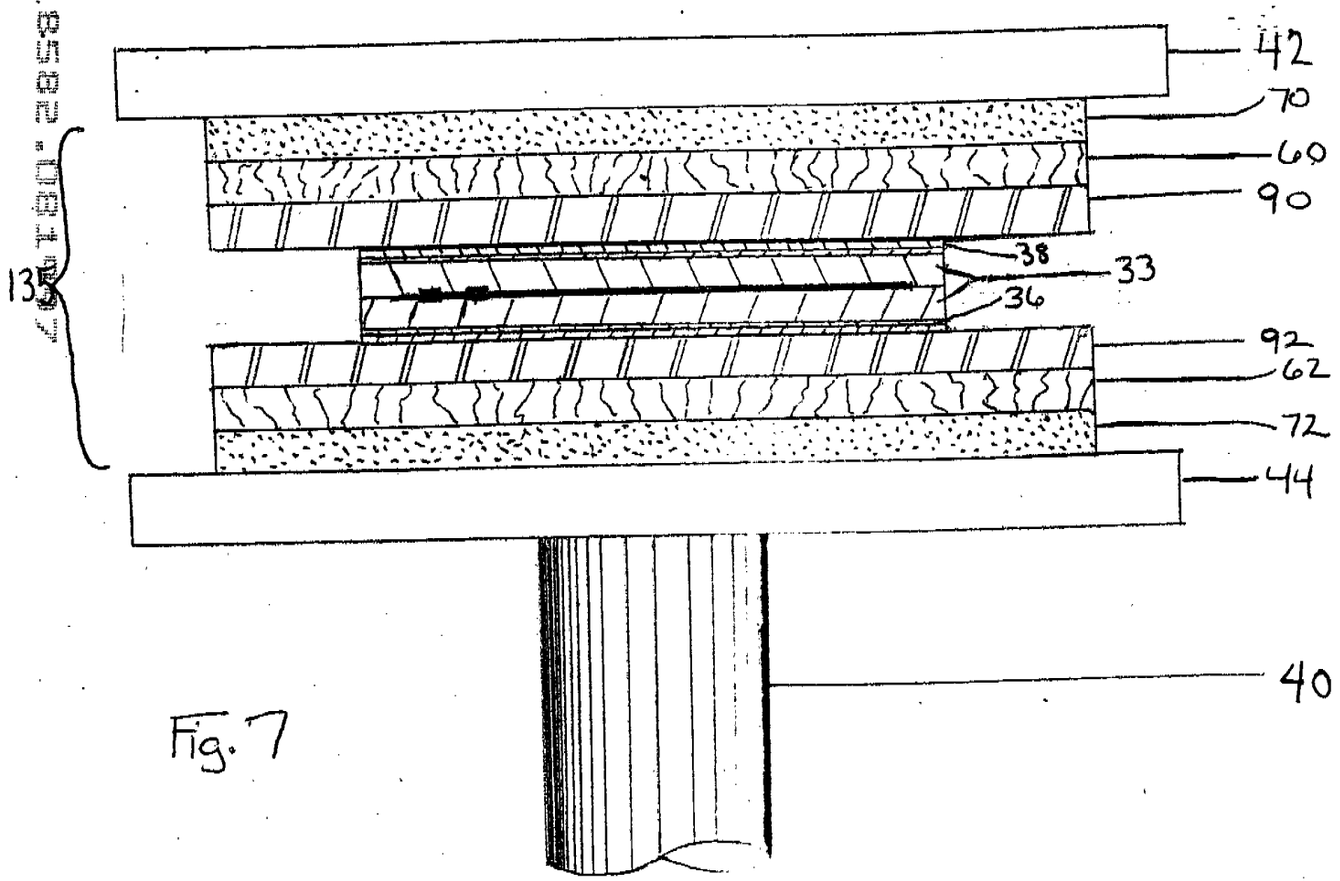


Fig. 7